GAS JOURNAL, JAN. 8, 1941

VOL. 233 93rd YEAR No. 4051

EDITORIAL NOTES

GAS IN NATIONAL DEFENCE

As in this country, so in America the Gas Industry has equipped itself by extensive research and experiment to fit in to a far greater degree in the programmes of National Defence. We were very interested to read in the December issue of the *American Gas Journal* quite a stirring Paper—it was presented at the recent annual convention of the American Gas Association—on the industrial contribution of gas in this direction in the United States. It was by Mr. Franklin T. Rainey, who is Chairman of the Industrial Section of the American Gas Association. During the last War there was no adequate number of industrially trained personnel in the Gas Industry either in this country or in America, no gas fired equipment as we know it to-day. True, large quantities of gas were employed for munition purposes of all types, but much of this gas was utilized by makeshift methods and by men unprepared by experience or training in its efficient application. It can be said broadly that efficient heating methods and applications had not then been evolved. To-day we are reaping the benefits of systematically planned and far-sighted policies adopted by most gas undertakings individually and in co-operation not only among themselves but with the manufacturers of the equipment, and—not least—with the industrialists themselves, the users of the fuel and the apparatus in which it is consumed. We have many well-trained industrial gas salesmen (we prefer the term " engineer " to " salesman " in this respect), we have many well-established contacts, and we think that we have in large measure won the trust and confidence of industry generally. Much, of course, remains to be accomplished, but a great deal has been achieved during the past decade by quiet, persistent effort—effort which is now standing the Nation in good stead. It is during this decade that we have seen the setting-up of the industrial gas centres scheme, which has been largely responsible for the phenomenal extension prior to the present war of the use of town gas in the field of industry. It is true to say that wherever heat is used in process work gas can almost certainly be found. In the heavier industries, furnaces and equipment using gas have grown to such an extent that demand outstrips supply. These developments are largely the result of the fact that through the centres organization the experience of the Industry can be put at the disposal of any member undertaking in a very short time—a factor of importance in peacetime and of even more importance in time of war.

RESULTS OF RESEARCH

Mr. Rainey spoke of the results in America of patient work carried out in the States with a similar policy of faith and enthusiasm in the industrial load. In America, as in our own country, through co-operation between the Gas Industry and gas equipment manufacturers there has been developed since the last War superior methods and gas heating equipment for industry. These have resulted in the wider availability of better steel, bronzes, and other metals than were formerly obtainable. We now have inert atmosphere furnaces which permit the maintenance of bright surfaces for metals ; atmospheres which reduce the formation of surface oxides on metals and prevent decarbonization. There have been developed furnaces for carbonizing metals using gas not only as a source of heat but as the hardening agent. Many types of continuous furnace have been developed, with heat-resisting alloy mechanisms for conveying materials at high temperatures, under exact temperature control and exact fuel proportioning, producing definite results. Then, of course, there is the rôle of the Gas Industry as a large producer of chemical compounds needed in warfare. Mr. Rainey mentioned that gas is almost the sole fuel in the chemical plants producing pure molybdenum and pure tungsten ; and a new and important development is the production of beryllium oxide and alloying it with copper to give copper the hardness and resiliency of steel. This alloy is not prone to sparking under abrasion, and therefore has great importance in munition production where explosive materials are processed.

We think it of interest to mention, if only in brief, two specific items among many set out by the Author regarding the use of gas in connexion with America's National Defence Programme—first in the production of the modern tank ; secondly, in the building of the modern battleship. In regard to the former, gas not only provides the fuel for some fifteen different heating operations to which the armour plate must be subjected, but also, through chemical action of its carbon content with the steel, it furnishes that required hard surface to a thickness approximately ten times greater than any similar surface requirement needed in any product of commercial life. To approach this quality of product in the last War would have required a heating cycle of from 400 to 600 hours. To day, thanks to research, a far superior result can be achieved in approximately 100 hours. Mr. Rainey gave a rough estimate of the amount of gas required for the many heating operations involved in the production of a tank. For the medium size tank, he said, approximately 500,000 cu.ft. of town gas will be required ; and since a production of 200 to 300 tanks a day is being considered to meet America's needs, the magnitude of the potential load is apparent. In regard to naval construction, in the shipyards are to be found gas fired furnaces ranging in size from an ordinary shoe box for soldering and rivet heating up to a fifty-room house for the annealing of a complete gun turret 50 ft. in diameter, weighing 40 tons, and operating at 1200°. The operation uses over 1,000,000 cu.ft. of gas for each anneal. These furnaces, said Mr. Rainey, are the largest in the world, and when not in use for annealing they are equipped with gas fired unit heaters and used as shops. The Author referred specifically to the *North Carolina*, a 35,000 ton battleship having three triple turrets each mounting three 16-in. guns. Forty million cu.ft. of gas were required in the building and assembling of this ship in the Navy Yard. In addition to this amount, one has to consider the vast quantities of gas needed in making the many parts and articles of equipment which go into such a vessel.

AN INDUSTRY PREPARED

It is apparent that the American Gas Industry is prepared to play, and, indeed, is now actually playing, a far more extensive part in America's present National Defence Programme than it did in the previous War. During the twenty odd years which have intervened the Industry has brought to realization a programme of steady and continued progress. To quote from the final passage of Mr. Rainey's Paper : " Then we had little to offer excepting a fuel, and many times we could not even offer that in the amounts required by a programme of such magnitude.

Since then, viewed from a nation-wide perspective, we have multiplied our production, transmission, and distribution facilities many many times, to the end that practically all of our major industrial centres are adequately served. Where we had few, if any specialists then in the art of proper and economical utilization, we now have thousands of industrial engineers trained and experienced for the task we face. In co-operation with industry and equipment manufacturers, we have helped evolve and develop new processes and methods which, when applied to the instruments of modern warfare, make possible the superlative qualities expected for use with our modern Army, Navy, and Air Corps." The Paper is, indeed, a record of which not only the American Gas Industry but the Industry in our own country may well be proud.

Personal

Gas Light and Coke Engineering Staff

The Gas Light and Coke Company regrets to announce that on account of ill-health, and on the advice of his doctors, Mr. R. W. HUNTER, M.Inst.C.E., has resigned his appointment as Chief Engineer. Mr. Hunter had held that position for upwards of five years, having succeeded Mr. Thomas Hardie in 1935.

Mr. Hunter began his career in the Gas Industry 43 years ago as pupil of his father, the late Robert Hunter, Engineer and Manager of the Chester United Gas Company. After this preliminary training he was appointed an Engineer Staff Pupil with the Gas Light and Coke Company in 1902, and has remained with the Company ever since. With the exception of comparatively short attachments to the Kensal Green, Bow Common, and Bromley Stations of the Company, practically the whole of Mr. Hunter's service was at Beckton Works, where he succeeded Mr. W. B. Leech as Station Engineer in 1927, and acted in that capacity until 1935.

During the World War, Mr. Hunter proceeded overseas in December, 1914, with the "Rangers," 12th London Regiment (largely composed of Gas Light and Coke Company personnel), serving in France and Flanders until invalided out in 1918 with the rank of Captain. He was re-commissioned in 1923, and helped to restore the link between the Regiment and the Gas Light and Coke Company.

Mr. Hunter is a member of the National Joint Industrial Council, and of numerous Committees connected with the Industry. He is a member of Council and Junior Vice-President of The Institution of Gas Engineers, having joined the old Gas Institute as an associate member in 1900. In 1933 he was awarded the H. E. Jones' Gold Medal for a paper on the Coke Oven Plant at Beckton.

Mr. Hunter takes with him the very best wishes of a wide circle of colleagues and friends for a speedy return to complete health, and for many years of happy retirement.

* * *

The appointment is announced of Mr. F. M. BIRKS, O.B.E., as Chief Engineer in succession to Mr. R. W. HUNTER.

Mr. Birks was appointed Deputy Chief Engineer in January, 1936. He began his career as a pupil of Messrs. Fielding & Platt, Engineers, Gloucester. Having completed his training he joined the staff of the firm and was engaged for a time on factory and engine erection in the Argentine. Mr. Birks returned to England where he joined the Swansea Harbour Board as Mechanical Assistant to the Chief Engineer, and was engaged for some years on the equipment of the Kings Dock completed in 1909. He then worked for a year in Brazil on the contruction of the Para Harbour, returning in 1911 to the Swansea Harbour Board as Chief Assistant Engineer (Civil and Mechanical).

Mr. Birks spent four years in France during the last war in the Mechanical Transport.

He left Swansea in 1921 to become Mechanical Engineer at the Gas Light and Coke Company's Works at Beckton, where he remained until 1929, when he went to Westminster as Mechanical Engineer to the Company.

* * *

Mr. H. Moys, Station Engineer at the Company's Beckton Works, has retired, and in his place the Company has appointed Mr. STEPHEN HAY.

Mr. Moys was educated at Dewsbury Wheelwrights' Grammar School and Yorkshire College, Leeds. Joining the Company as an Engineer Staff Pupil in 1901, he spent some time as an Assistant Engineer at Kensal Green, Shoreditch, and Nine Elms. He spent nine years at Beckton in various capacities and afterwards joined the Distribution Department as Assistant to the Distributing Engineer, with whom he remained until 1920, when he became Deputy Engineer at Bromley. He was appointed Station Engineer at Bow Common in 1922, at Shoreditch in 1932, and at Bromley in 1933, where he remained until he was appointed Station Engineer at Beckton in 1936.

Mr. Moys takes with him the good wishes of all for happy retirement and good health.

Mr. Stephen Hay was educated in Scotland. He joined the Gas Light and Coke Company as a Staff Pupil in 1909, and was then appointed Junior Assistant to the Engineer at Beckton in 1913.

Mr. Hay served with distinction during the Great War. He joined the Flying Corps in 1916 and was awarded the A.F.C. He returned to Beckton in February, 1919, becoming Senior Assistant Engineer in 1926. In 1928 he was appointed Assistant Resident Engineer and in 1930 Deputy Station Engineer, which post he has held until his present appointment.

* * *

The completion of fifty years' service with the York Gas Company by Mr. CHARLES WATSON was signified recently by the presentation to him of gifts. Mr. Watson is still in harness as Showroom Manager at the Company's premises in Davygate, and on behalf of the Directors Mr. G. A. Potter Kirby (Chairman) presented him with an inscribed silver salver. Mr. H. E. Bloor (Director and Secretary), on behalf of the Staffs, handed Mr. Watson a Westminster chiming clock and a silver jug. Tributes were paid in speeches by the older employees, and also the youngest. It is interesting to note that Mr. Watson's father served the Company for 42 years.

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To fill the vacancy caused by the death of Sir Charles L. Morgan, C.B.E., the Directors of the Bournemouth Gas & Water Company have elected Mr. PHILIP G. G. MOON, M.Inst.C.E., F.C.S., to a seat on the Board, while Lieut.-Colonel H. W. WOODALL, C.I.E., becomes Deputy-Chairman. Mr. Moon will continue to act as Engineer and General Manager, and Mr. J. T. HAYNES has been appointed Deputy Engineer and General Manager.

* * *

From the Gas Light and Coke Company's *Co-Partners'* Magazine we learn of the retirement, after 50 years' service with the Company, of Mr. FREDERICK PIERSON. He was perhaps best known to the Industry for his kindly way of dealing with those wishing to importune the Governor, whose Private Secretary he was for a number of years. When Mr. Wood succeeded Mr. Galbraith as Secretary of the Company early in 1937, Mr. Pierson became Assistant Secretary.

* * *

Chief Technical Assistant to Derby Gas Light & Coke Company for several years, Mr. E. HEMINGWAY JONES, of Green Bank, Quarndon, has been appointed Combustion Engineer in charge of the fuel control department of a large iron and steel works in the West of England. Mr. Jones joined the Company in 1912 as a junior assistant, and when the industrial use of gas was developed he was promoted Chief Technical Assistant.

Obituary

Harold E. Copp

The death occurred on Dec. 29, in his 66th year, of Mr. HAROLD E. COPP, M.Inst.C.E., a past-President of The Institution of Gas Engineers and for many years Engineer and Manager of the British Gas Light Company's Hull Station.

Mr. Copp was the youngest son of the late Mr. W. L. Copp, who was closely associated for many years with the Gas Industry in the West of England and was inventor of the first anti-dip valve for attachment to hydraulic mains, used extensively by London Gas Companies about sixty years ago. Educated at Wycliffe College, Mr. Harold Copp began his career in the Gas Industry in 1892 as a pupil under the late Mr. Fletcher W. Stevenson, then Engineer to the Sheffield Gas Company. Later he acted as Clerk of Works on the construction of the Grimesthorpe Station of the Sheffield Company and acquired considerable experience on large civil engineering works. He studied at Sheffield University College, gaining certificates in technical subjects, including civil engineering, metallurgy, and chemistry. In 1896 Mr. Copp left Sheffield to become engineering assistant to the Stockport Corporation Gas and Electricity Department, being subsequently appointed Assistant Gas and Electrical Engineer. In 1902 he went to West Bromwich to take charge of the Corporation Gas Undertaking, where he designed and carried out many improvements and additions to the works. He also conducted a series of experiments on the enrichment of blue water gas by Peebles oil gas plant, worked in conjunction with the Dellwik-Fleischer blue water gas plant. In 1908 he was elected President of the Midland Association of Gas Engineers and Managers.

Mr. Copp's connexion with the British Gas Light Company began in 1914, when he was appointed Engineer and Manager of the Potteries Station. Here he was responsible for the erection of one of the first plants for the production of benzole and toluole. The design of this plant was afterwards adopted by many other gas-works. On the retirement of Mr. John Young in 1919, Mr. Copp was transferred to

the Hull Station, and under his management the works and plant were largely extended and improved. After twenty years' service with the British Gas Light Company, Mr. Copp retired in September, 1934.

Mr. Copp was President of The Institution of Gas Engineers in 1930–31 and presided at the First International Gas Conference, held in London on June 3, 1931. He was Vice-President of the International Gas Union till September, 1934.

Dr. Bernard Friedman

It is with deep regret that the Industry will have learned of the sudden death on the night of Thursday, Jan. 2, of Dr. BERNARD FRIEDMAN, Managing Director of Ascot Gas Water Heaters Ltd. We understand that Dr. Friedman was working as usual at his office up to late afternoon that day, and left for home presumably in good health.

In the comparatively short time during which Dr. Friedman built up the extensive and flourishing business which will always be associated with his name, he had endeared himself to a very wide circle of friends by a lovable personality. It was only natural that such a rapid rise to fame as that of Ascot Heaters should not be unaccompanied by business rivalries, but the finest possible tribute to him as a man was the personal regard, and often affection, which his competitors had for him. To his capacities as a technician and business organizer ample testimony is borne by the fact that "Ascot" is almost a household word throughout the land—little more than ten years after Dr. Friedman began its manufacture in this country.

We shall give some particulars next week of his career. In the meantime we join with many of our readers who will wish to express their sympathy to the family, and to that very much larger "family"—"Ascot" employees of every grade—whose welfare was Dr. Friedman's special joy, and whose affection for him has been revealed to us on many occasions when we have been among them.

A New Carbonizing Plant in the North

Prior to 1937 the gas producing plant of a Yorkshire Gas Company consisted of stop ended, hand charged horizontal retorts and carburetted water gas plant. The United Kingdom Gas Corporation having acquired a controlling interest in the Company, and it being decided that the plant required modernization, tenders were invited for a carbonizing plant having an initial capacity of 1¼ million cu.ft. of gas per day when carbonizing South Yorkshire coals, the quality of the gas to be 500 B.Th.U. per cu.ft. All necessary coal and coke handling plant had to be included for the new plant and provision made for the extension of the plant by 50%. It was finally decided that an intermittent vertical chamber plant should be installed, and an order was placed with Messrs. Gas Chambers & Coke Ovens, Ltd., for an installation of their C.O.L. intermittent vertical chambers.

The plant has been erected and the working results have proved eminently satisfactory.

Industry's Task in the New Year

The following is a message from Lieut.-Col. Lord Dudley Gordon, D.S.O., President of the Federation of British Industries: During the closing days of 1940, the attention of the whole world was drawn first to Lord Lothian's speech, delivered for him by another immediately before his death in America, and then to the statement on the war by the Prime Minister in the House of Commons.

Both these pronouncements emphasized that 1941 must be the critical year for the British Empire and for the cause of freedom in the world. This coming crisis in 1941 can only be met by the successful endeavours of industry to supply the fighting forces, with which it is proud to be in partnership. The great industrial effort in the United States added to our own will ensure overwhelming superiority by 1942, but it is industry in Great Britain which has to bear the strain and provide the main requirements of 1941. Industry will not fail to respond to this urgent call for redoubled efforts in spite of enemy attempts to terrorize and to destroy.

To achieve our purpose there must be rigorous cutting down of unessential goods and services. At the same time, it is necessary to exercise the utmost care in planning in order that man power and productive resources thus released shall be quickly reabsorbed. In this effort, as in others, the Federation of British Industries has kept in consultation with the Government and will continue to give its active co-operation in order that dislocation and delay may be reduced to a minimum.

I have no doubt that the coming year, stern and arduous as we may expect it to be, will lead us and the world to the success of our cause—freedom.

Money in Exports*

Those who are engaged in the expansion of our export trade, which has now become such a vital branch of our war effort, will find *Money in Exports*, by Walter Buchler, a useful volume. Each chapter deals with a different market, its local methods and business practices, the dangers and pitfalls to be avoided, and how trade can be developed with that country.

Besides giving a comprehensive account of the various countries, their customs, and all the dependent factors bearing on their trade, the author introduces much practical advice, such as: "While Portuguese merchants are always ready to receive callers, the best time for a visit is not long before lunch, if you want to finish your business quickly, as their impatience will grow with the approach of noon. If you see him immediately after lunch, however, you will find him at leisure and in the best of humour." From which it will be seen that the author has treated his subject in such a way that the book will be of much interest also to the layman, covering as it does what may be termed the "romance of trade."

In a prefatory note it is explained that, in the firm conviction that justice and liberty will triumph, bringing back normal conditions, the writer has disregarded the war as a purely temporary interlude, and has included the peacetime information about various countries which are the scene of hostilities or in enemy occupation and hence outside the sphere of normal trade.

* Useful Publications, 523/4 Mansion House Chambers, E.C. 4. Price 10s. 6d.

Mr. A. L. Holton

Retirement from Manchester Chief Engineership

The popularity of Mr. Holton among both the Staff and workmen of the Manchester Corporation Gas Department was evidenced by the many presentations which were made to him on his retirement from the position of Chief Engineer.

The chief officials of the Gas Department entertained Mr. Holton at a luncheon, and presented to him a beautiful silver teapot, and the Partington Welfare Committee gave him the cream jug and sugar bowl to match. The chief officials of the various Departments of the Corporation were to have presented him with a silver coffee jug, but the presentation had to be deferred owing to unwelcome guests visiting the City on the previous two nights. The staff at the Bradford Road Works presented him with a monks' bench, and the Street Mains and Lighting Department and his own personal staff presented him with an antique silver condiment set.

On Dec. 18 Mr. Holton entertained fifty of his friends at luncheon at the Engineers' Club, Manchester. In welcoming his guests, he said that it was extremely difficult, if not impossible, for any man to tabulate a list of those to whom he was indebted for helpful and friendly counsel, or those to whom he had been privileged to be of service. There were, however, a number of friends about whom no such ambiguity existed, and these friends were his guests at the luncheon. They included his colleagues, his business friends, his medical adviser, and his chauffeur, and he considered himself happy in having had the privilege of their genial friendship.

SIR FREDERICK WEST, in a happy after-luncheon speech, said that he was delighted to be present in such a friendly atmosphere. It was not his intention to endeavour to cover Mr. Holton's career in the Gas Industry in formal language. It was not his intention to deal with the eminence he had attained, nor to refer to his relations, as a contractor, with Mr. Holton, except to say that he had always found him generous and fair in all his dealings. He always looked upon Mr. Holton as having two outstanding characteristics, and these were his capacity for making and retaining friends, and his cheerfulness. He had gathered around him his friends, and the atmosphere indicated very clearly how successful he was in choosing his friends. One of Mr. Holton's characteristics was undoubtedly the manner in which he had cultivated friendship and good fellowship with those with whom he had come into contact. He also radiated cheerfulness and enthusiasm, and during a particularly trying period when Mr. Holton was in the nursing home, it was a genuine pleasure to call in to see him.

Mr. GEORGE DIXON, after a very racy and amusing opening, said in a more serious vein that Mr. Holton had always been helpful to the Industry by his experimental and original work, and also in his contributions to the technical Press. He had always taken a keen interest in the technical associations, and had occupied the position of President of both the Junior and Senior Associations. He had also occupied the position of Chief Engineer to the great City of Manchester.

Colonel W. M. CARR said that he had been associated with Mr. Holton for many years. He was of small stature, but nevertheless he was a very big man, for nothing was ever too much for him. He had never refused to do any job and to tackle it thoroughly. Mr. Holton was not going to retire. He was too good to retire, and he had agreed to help him (Col. Carr) in some of his work, and give the use of his great brain.

Alderman Sir WILLIAM KAY referred to Mr. Holton's appointment to the Bradford Road Works in 1902, and to his rise to the position of Chief Engineer to the Manchester Corporation Gas Department.

"Gas Journal" Calendar and Directory, 1941

We regret that all our efforts have failed to produce copies quite on time. The new Edition should be in the hands of subscribers shortly, and we must ask indulgence for a delay which is due to the difficulties of publishing in present conditions.

THE HYDRAULIC SEAL IN GASHOLDER CUPS

A Paper to The Institution of Gas Engineers

[Communication No. 236]

By S. M. MILBOURNE,
Assoc.Inst.Gas E., M.I.Struct.E.,
Joint Managing Director, C. and W. Walker, Ltd.

(*Continued from p. 31*)

Gas may be prevented from escaping past the drill by means of cotton waste held firmly round the hole in the dip hanging row plates. Holes about 1¼ in. diameter may be drilled in the cup plates in the required positions, and these should be sufficient in number to ensure that the cup becomes adequately flooded at its maximum rate of descent; otherwise, the cup may still "blow" when uncupping. It is obvious from an examination of Figure 6(b) that the lower the flooding holes are placed in the cup plate the greater will be the margin of safety against "blowing", but care must be taken to ensure that sufficient water is carried up with the cup as the holder is inflated, to form an adequate amount of seal under the varying conditions of pressure and other practical considerations which are involved in the design of gasholder cups. The more general practice on the Continent is to construct the cup and dip of a water-sealed holder with a comparatively shallow cup. In this case the dip plate is extended some appreciable distance above the dip channel, in the manner indicated in Figure 8(a). Provided this form of cup is properly designed, no flooding holes are required, as the curtailed cup plate enables the flooding of the cup to take place early during the process of uncupping. Another design of cup and dip, which obviates the necessity of flooding holes, is shown in Figure 8(b). In this instance the dip channel is fitted with specially deep bearing blocks, while the cup plate is curtailed as shown.

"Blowing" of the cups in the manner just described may also be prevented by arranging for the water level in the tank to be above the top of the dips of the grounded lifts. This enables flooding of the cups to take place over the dip channel before the lifts disengage. The latter method of preventing "blowing" is not now generally favoured, as the dips of the stationary lifts are always awash and render inspection or oiling of the dip carriages somewhat inconvenient.

Lowering of the water level in the tank has been found effective in preventing "blowing" of the cups in the case of some existing holders, but this method should be carefully investigated before being adopted, to ensure that an adequate amount of seal is maintained in the cups of the flying lifts as the holder is inflated. Care should also be taken to see that the dip compartments are sealed in the tank water when the gasholder is out of commission.

Extension pieces attached to the dips of the stationary lifts, as previously described and indicated in Figure 5, may also prove effective in preventing "blowing" of the cups, provided water was previously found to overflow the dips when the lifts were cupped or uncupped, or where an appreciable quantity of water was lost from the cups of inflated lifts through the action of the wind.

In order that the hydraulic seal in gasholder cups shall be properly investigated, it is necessary for attention to be given to the variation of the levels of the water in the cups and tank during the inflation and deflation of the holder. As it is a simpler matter to follow the movement of the water levels during deflation of the holder, this operation will be considered first.

A careful study of the various positions of the cup and water levels as the cup becomes submerged in the tank, discloses that under the usual working conditions there may be from four to six critical stages leading up to the point at which the hydraulic seal may "blow". By a critical position or stage is understood the point at which a sudden change in the rate of variation of the water levels will take place. It will be realized that the movements of the water, as the descending cup becomes submerged, may be interpreted by a series of mathematical functions. These functions necessarily become discontinuous as each critical stage is reached. Many of the difficulties which arise when the positions of the water levels in the cups require to be determined, are due to the fact that the succession of critical positions for the cup and water levels is not always apparent. The diagram shown in Figure 9 indicates the full sequence of these critical positions from the first stage (I) to the sixth stage (VI) and these may be described as follows:

(I) Cup channel touches water inside holder as lifts descend.
(II) Water in cup commences to over-run dip channel.
(III) Hanging lift about to land on rest blocks in tank.
(IV) Gas trapped in dip commences to blow under cup channel into holder as hanging lift is landed.
(V) Hanging lift landed and uncupping about to commence.
(VI) Cup descends into tank water until trapped gas in dip is about to blow under dip plate.

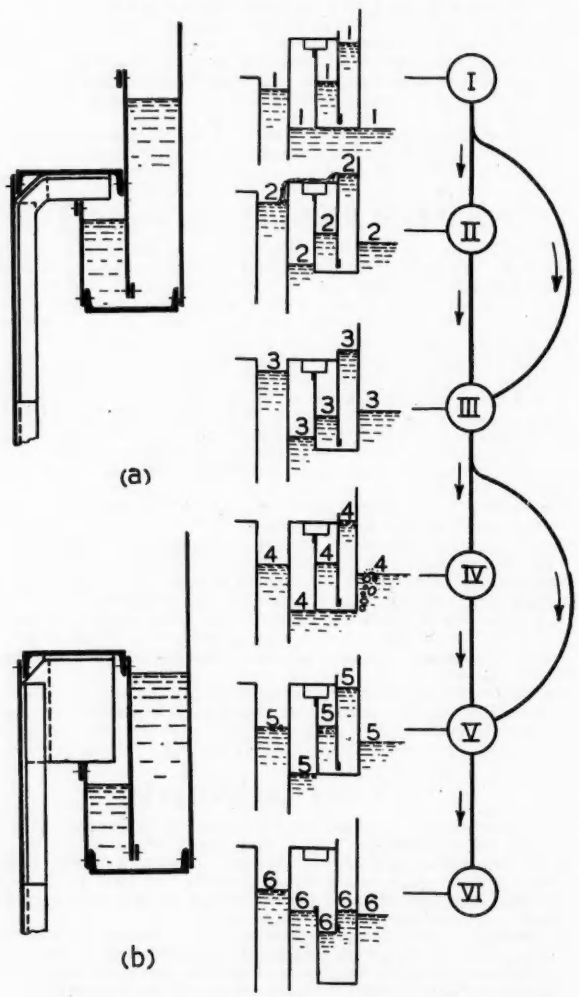

FIGURE 8.
General Arrangement of Cups and Dips having Curtailed Cup Plating.

FIGURE 9.
Diagrammatic Representation of the Sequence of the Various Critical Stages During the Uncupping Operation.

The effective sections of the cup and dip on the left of the diagram have been indicated in order to illustrate more clearly the six critical stages enumerated.

It will be observed that the critical positions (II) and (IV) will not necessarily arise in every case. The water from the cup may not over-run the dip channel before the hanging lift is about to land, and similarly it follows that the gas trapped in the dip may not necessarily blow under the cup channel as the hanging lift is landed. The loop lines shown in Figure 9, connecting positions (I) to (III) and (III) to (V), are therefore intended to indicate that stages (II) and (IV) are not necessarily included in all sequences. On referring to Figure 9 it will be seen that only four different sequences of critical stages are possible as a lift uncups, and these may be stated thus:

(*a*) (I) (II) (III) (IV) (V) (VI)
(*b*) (I) — (III) (IV) (V) (VI)
(*c*) (I) (II) (III) — (V) (VI)
(*d*) (I) — (III) — (V) (VI)

The following investigation makes use of a semi-graphical semi-analytical method, and this has the advantage that the water levels may be readily checked if each stage is indicated on a scale drawing of the effective cup and dip section.

VI DETERMINATION OF WATER LEVELS IN TANK

A number of the more important features and assumptions upon which the theory of gasholder cup seals has been developed, are briefly described as follows:

(*a*) When considering the volume of trapped gas in the dip, it has been assumed that this volume remains constant throughout the changes in pressure, except in instances where the trapped gas escapes beneath the cup channel. Actually, the volume of trapped gas in the dip varies slightly as the pressure changes, but this variation is so small for ordinary gasholder pressures that it may be neglected.

(*b*) Measurements in regard to the width of the compartments of the cup and dip are taken from the centres of the plating in all cases and no variations in the volume of water in the cup or trapped gas in the dip have been considered on account of the thickness of the cup and dip plates.

(*c*) As each telescopic section of the holder is deflated, a certain amount of water in the tank is displaced, owing to the submergence of the sides of the lift and the cup of the subsequent lift. If the water in the tank is below the level of the overflow, this action tends to raise the water level generally. The extent to which the water level inside and outside a floating lift will rise or fall accordingly as the holder is deflated or inflated, may be determined as follows: Let W = the normal weight in air in lb. of the portion of the lift which is submerged when at rest. Now the water level in the holder and tank will rise or fall by an amount equal to

$$k = \frac{W}{32{\cdot}74\ D^2} \qquad \text{.....(1)}$$

where D = the diameter of the tank in feet,

k = the rise or fall of the tank water level in inches inside and outside a lift as it becomes fully deflated or inflated.

For all practical purposes, W may be taken as the weight of the complete lift, including cup and dip, or dip and bottom curb in the case of the outer lift. So far as the inner lift is concerned, only the sides and cup are included in the weight W, as the trussed crown framing is not usually submerged to any appreciable extent when the lift is at rest. The variation of the general water level in the tank due to the displacement of material is usually from 0·18 to 0·4 in. for each lift.

(*d*) When a lift uncups, the fall in the pressure thrown by the holder is accompanied by a fall of the water level on the outside of the landed lift. It is permissible to assume that the fall of the level of the water in the tank outside the landed lift is equal to the pressure thrown by this lift. Actually the water level inside the holder alters slightly as the lift uncups, but the relative movement is generally so small that it may be neglected.

(*e*) It is assumed that the surface of the tank water inside the floating holder is unbroken during the cupping or uncupping operation. If a large dumpling (such as is sometimes present in an underground tank of brick or concrete construction) breaks the surface of the water in the holder at any time during the cupping or uncupping operations, it is obvious that special treatment would be necessary, as the relative rise and fall of the water levels inside each floating lift are then considerable.

(*f*) If the holder, after being fully inflated, is partly deflated and remains so for some considerable time during wet weather, it is evident that the water level in the holder and tank may rise until the water level in the tank is level with the overflow. Such a condition will obviously render the cups of the inflated lifts more liable to "blow" when these lifts are eventually uncupped. It is therefore necessary, when investigating the positions of the water levels in the cup seals, to determine the most unfavourable positions of the water levels in the tank and holder as the lifts cup and uncup. These positions will obtain when the water in the tank is at its highest and lowest possible levels. When any lift is approaching the uncupping stage, the highest level of the water will be in line with the tank overflow, even when the tank is out of level. The lowest position of the water in the tank when any lift is cupping will be reached when the holder has been previously fully inflated and is afterwards deflated during dry weather. In this case the water level outside any floating lift approaching the cupping position may be represented by the general expression:

$$q_t = p_a - p_f + \Sigma(k) \qquad \text{.....(2)}$$

where q_t = the distance in inches from the normal overflow level to the tank water level,

p_a = the total pressure of gas in inches w.g. thrown by the fully inflated holder,

p_f = the total pressure of gas in inches w.g. thrown by the floating lift,

$\Sigma(k)$ = the sum of the values of k for the lifts already fully inflated.

The distance q_h in inches from the normal tank overflow level to the water level inside a floating lift of the holder will then be:

$$q_h = p_a + \Sigma(k) \qquad \text{.....(2a)}$$

These expressions for the lowest levels of the water in the tank and floating portion of the holder are based upon the assumption that the variation of the water level inside the holder is only due to the submergence of material forming the sides of the lifts. If an allowance for evaporation of 1 in. is made for the water in the tank, the final expressions for determining the lowest water levels in the tank and holder just before the cup of any lift commences to submerge, may be stated thus:

$$q_t = 1 + p_a - p_f + \Sigma(k) \qquad \text{.....(3)}$$

and

$$q_h = 1 + p_a + \Sigma(k) \qquad \text{.....(3a)}$$

A gasholder tank may subside in such a manner that the lowest point lies in the direction of the tank overflow, in which case the average depth of the water in the tank will be rather less than the normal depth if the tank were level. If the tank sinks on the opposite side to the overflow, then the average depth of the water will be slightly more than the normal depth if the tank were level. The effect of these differences in tank levels will be to cause the cups of the deflating lifts to come into contact with the water in the tank relatively earlier or later, depending upon whether the average depth of water in the tank is greater or less than the normal depth. The average depth of the water in the tank is not, of course, affected by differences in level of the tank which may take place at right angles to the axis on which the overflow is situated. The most unfavourable condition so far as the uncupping operation is concerned will be when sinking of the tank takes place on the side opposite to the overflow, as "blowing" of the cups is then more liable to occur. The most unfavourable condition, so far as the cupping operation is concerned, is therefore when the tank subsides on the same side as the overflow. In this case the average depth of the water in the tank will be less than the normal depth and this condition will tend to reduce the amount of water picked up by the cups as the lifts become inflated.

When investigating the cupping and uncupping operations of existing gasholders in which further subsidence appears unlikely, actual measurements may be taken at the point of overflow and at a position diametrically opposite. These measurements, which may conveniently be made from the water level in the tank to the root of the top angle curb, will indicate the direction in which the tank is sloping.

Let m = the extent in inches by which the tank is found to be out of level across the two points previously described. The highest and lowest average positions of the water in the tank outside any floating lift may then be classified as follows:

(i) The tank is found to have subsided m in. at the overflow. Under these conditions the highest average level of the water in the tank outside any floating lift will be $m/2$ in. below the normal position of the overflow if the tank were level. This may be stated in the form of an equation thus:

$$q_t = m/2 \quad \text{.....(3b)}$$

The highest position of the average water level inside any floating lift under the above condition will then be

$$q_h = p_f + m/2 \quad \text{.....(3c)}$$

The lowest average level of the water in the tank outside any floating lift may therefore be obtained by introducing the value $m/2$ to equation (3) so that

$$q_t = 1 + m/2 + p_a - p_f + \Sigma(k) \quad \text{.....(3d)}$$

Then the lowest average level of the water inside any floating lift under these conditions may be stated as follows:

$$q_h = 1 + m/2 + p_a + \Sigma(k) \quad \text{.....(3e)}$$

(ii) If the tank is found to have subsided m in. at a point on the tank diametrically opposite to the overflow, then the highest average level of the water in the tank outside any floating lift will be $m/2$ in. above the normal position of the overflow if the tank were level. This may be stated thus:

$$q_t = -m/2 \quad \text{.....(3f)}$$

The minus sign in the above expression denotes that the relative position of the tank water level is above the normal position of the overflow if the tank were level.

The highest average position of the water level inside any floating lift under the foregoing condition will then be

$$q_h = p_f - m/2 \quad \text{.....(3g)}$$

The lowest average level of the water in the tank outside any floating lift may then be obtained by introducing the value $-m/2$ to equation (3) so that

$$q_t = 1 - m/2 + p_a - p_f + \Sigma(k) \quad \text{.....(3h)}$$

The lowest average level of the water inside any floating lift under these conditions may be stated as follows:

$$q_h = 1 - m/2 + p_a + \Sigma(k) \quad \text{.....(3i)}$$

So far as newly erected gasholders are concerned, it is generally impossible to forecast the direction in which subsidence of the tank may take place; therefore allowances will require to be made for the most unfavourable conditions likely to obtain. It has already been shown that if the tank sinks in the direction of the overflow, the condition is more unfavourable to the cupping operation of the lifts. If subsidence of the tank takes place on the opposite side to the overflow, then the condition is more unfavourable to the uncupping operation. When designing new holders it is therefore advisable to allow for subsidence of the tank in either direction; then the highest levels of the water in the tank outside and inside any floating lift may be determined from equations (3f) and (3g) respectively. The lowest levels of the water in the tank outside and inside any floating lift may also be ascertained from equations (3d) and (3e) respectively. If an allowance of 1 in. is made for possible subsidence of the tank, then the maximum and minimum values of q_t and q_h may be found after writing $m = 1$ in equations (3f), (3g), (3d) and (3e). In the case of existing holders, the value of m may be obtained from actual measurement.

In some instances where existing holders are considerably out of level, the low side of the lift may ground during deflation, before the bottom of the cup on the high side of the subsequent lift has touched the water in the tank. Such a condition may permit uncupping to take place before the inside lift is properly sealed in the tank water. Similar conditions are sometimes brought about if the level of the water in the tank is allowed to fall too far below the overflow. Where such cases are found to exist, immediate steps should be taken to remedy the defects. All water-sealed holders should operate in such a manner as to ensure that when a lift is being deflated the underside of the cup is sealed in the tank water before the actual uncupping operation commences.

(To be continued in a forthcoming issue)

Materials for Gas Bags

The National Gas Association of Australia has published a Laboratory Report of tests conducted on materials for gas-bags for use on motor vehicles. The object of the tests was to determine the suitability of certain materials and methods of fabric proofing for use in the manufacture of fabric gas containers for use on motor vehicles. In the selection of materials and treatment, the minimum cost was sought.

The materials tested—we quote from the report—can be divided into two groups. First, those supplied ready proofed by the manufacturers, and subsequently made up into bags, and, secondly, fabric bags which were made up and subsequently treated to render them gastight.

The materials in the first group were thin rubberized fabric, neoprene with fabric backing on both sides, and fabric with rubber facing on both sides.

Those in the second group were bags made from aeroplane fabric proofed in the following ways: With linseed oil preparation, similar to that of an oilskin coat. With a special proofing preparation of phthalic anhydride-glycerine type.

Method of Tests

The bags, which were approximately 28 in. long, 12 in. wide, 8 in. deep, were tested for leakage on a gas line at 2 in. W.G. gas pressure. They were then placed in a room maintained at 70° C. and arranged so that a blast of hot air passed across the bags from two oscillating nozzles attached to the outlet of a blower. The blast passed across the bags approximately 30 times a minute. This treatment was used to simulate strong wind conditions. The bags were connected to a pipeline equipped with a time-controlled valve mechanism which caused the bags to be filled slowly to a maximum pressure of 2 in. W.G. and then after a time interval to be slowly deflated by a suction pump. The complete cycle from the start of one inflation to the start of the next inflation took approximately 20 minutes. At intervals throughout the test the bags were sprayed with water to simulate rainy conditions. The bags were removed at intervals throughout the test and the leakage determined.

All the leakage figures quoted below are in cu.ft. per hour per sq.ft. of bag surface.

Number of Inflations.	1. Rubberized Fabric ("Rubber Cloth").	2. Neoprene and Fabric.	3. Rubber and Fabric.	4. Linseed Oil Preparation on Fabric.	5. Proofed fabric (Phthalic anhydride-glycerine).
	Leakage — cu.ft./hr./sq.ft.				
0	0.003	0.020	0.020	0.027	0.002
102	—	—	—	0.264	0.151
114	—	0.042	—	—	—
162	—	—	—	—	Bag re-treated.
189	—	—	0.010	—	—
192	0.432	—	—	—	—
—	Seams dressed	—	—	—	—
309	—	—	0.018	—	—
327	0.396	—	—	—	—
354	—	—	—	—	0.040
366	—	0.014	—	—	—
489	—	—	—	—	0.617
501	0.408	—	—	—	—
555	—	0.018	—	—	—
675	—	0.025	—	—	—
763	—	—	—	—	0.802
	Fabric leaking and at inlet connexion	—	—	Fabric leaking	Fabric leaking and at inlet connexion.

Conclusions

It will be seen from the results that the rubberized fabric and the fabrics treated with linseed oil mixture and with phthalic anhydride-glycerine have not stood up satisfactorily to the conditions of test. A leakage of 0.02 to 0.03 cu.ft. per sq.ft. per hour has tentatively been accepted as the maximum permissible. The only two which gave a sufficiently low leakage figure after approximately 300 inflations and deflations were the bags made up from neoprene and from rubber layers with fabric layers. (It has since been ascertained that owing to war conditions, neoprene is unlikely to be available for use for gas bags.)

Two other materials have been proposed for this purpose, and until these have been tested, the investigations cannot be regarded as completed. It must be remembered that though suitably gastight bags can be obtained at a fairly high cost, these investigations are intended to show whether satisfactory materials can be obtained at much reduced prices.

CARBONIZATION OF COAL-OIL MIXTURES*

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THE purpose of this Paper is to bring to your attention certain facts relative to the use of residuum petroleum oils, highly viscous fuel oils, and other oils in the operation of coal gas plants of the coke oven type. The oil may be mixed with the coal in the hammer-mill and delivered to the ovens through the regular coal-handling operations, or added to the coal at the mines or elsewhere.

Our experiences with the carbonization of coal-oil mixtures will be described in two sections :

I. The use of relatively large quantities of oil on the coal, 1.0 to 3.5% by weight for the purpose of increasing the yields of gas and other products and for providing added flexibility with regard to products in a by-product coke oven plant.

II. The use of very small quantities of oil on the coal, 0.25 to 0.5% by weight, for the purpose of increasing the bulk density of the coal mix, thereby maintaining or increasing plant capacity and for controlling the moisture content, dust, and weathering of coals in transit or in storage.

Oil on Coal—1.0 to 3.5% by Weight, for Increasing Plant Yields

In most cases, fuel oil similar to bunker "C" grade has been used. In eastern plants oil of this type now costs about $1.25 to $1.35 per barrel of 42 gallons, delivered at the coke plant. This is equivalent to about $0.03 per gallon. These oils weigh 8.0 to 8.3 lb. per gallon and have a total calorific value of about 150,000 B.Th.U. per gallon, at 60°F.

Oils of the nature described must be heated to about 60°C. for handling. In most cases the oil has been added to the coal immediately before the hammermill in the coke plant. The only equipment required is a suitable pump with the necessary piping. A perforated pipe makes a satisfactory spray. If desired, storage tanks may be provided, but generally the tank cars can be used.

The quantity of oil used has varied from 1.0 to 3.5% by weight of coal, or from 2.5 to 8.5 gallons of oil per net ton of coal.

Based on long experience with the use of oil, the following is a conservative estimate of the products recoverable from each gallon of heavy fuel oil added to the coal charged to the ovens in a coke plant. A heat and weight balance is included.

	B.Th.U.	Weight.
Gas—60 cu.ft. (Standard Conditions) at 1180 B.Th.U. per cu.ft.	70,800	3.2 lb.
Tar— 0.3 gallons	45,000	2.9 lb.
Coke—1.7 lb. (20% by weight)	24,700	1.7 lb.
Unaccounted for	9,500	0.5 lb.
	150,000	8.3 lb.

Light oil—0.07 gallons (this is included in gas above).

These yields will vary considerably with different oils, oven temperatures, etc., but are believed to be representative.

While a coal gas plant of the coke oven type has great flexibility in gas output and coke production, especially if provided with interchangeable producer gas and coal gas underfiring, any development which will increase the flexibility should be warmly welcomed, especially if such a change makes it possible to produce peak-load gas, remove light oil with cheap B.Th.U. replacement, give a greater flexibility in ratio of coke production to gas output, and an increased control of gas gravity. We believe that the use of oil in coal mixtures will give such results. Such belief, however, is based largely on interpreted data, but the experiments have been carried on for such a long time that the conclusions are justified.

The whole subject of the addition of heavy oil to the coal charge has been a research problem of ours for many years. It was not until June, 1938, that a situation arose which gave the necessary impetus to the matter. At the plant of the Connecticut Coke Company, supplying gas for a large community, a light oil plant had been installed. Due to the necessity of maintaining a high specific gravity in the coal gas, the plant was designed to remove, from the gas, most of the toluene and xylene but only part of the benzene. If more of the lighter fractions were removed, the amount of producer gas dilution in the debenzolized gas would have to be reduced to such a low point that the specific gravity of the send-out gas would fall below specifications.

Typical coke oven gas production per ton of mixed high and low volatile coal, without light oil removal, amounts to approximately 10,800 cu.ft. at 580 B.Th.U. per cu.ft. and 0.36 specific gravity. This volume of coal gas can be diluted with producer gas of 130 B.Th.U. per cu.ft. and 0.9 specific gravity to yield 12,100 cu.ft. per ton of coal of 530 B.Th.U. gas and 0.42 specific gravity.

Coke oven gas contains about 3.0 gallons of light oil per ton of coal carbonized. If this light oil is removed, the diluted debenzolized gas amounts to 11,200 cu.ft. per ton of coal at 530 B.Th.U. and a rather low specific gravity of 0.37.

When coke oven gas is the base load and carburetted water gas the variable, such a gravity of this coal gas might cause undesirable fluctuation in the specific gravity of the mixed gas.

At our Connecticut plant, this low specific gravity of 0.37 was not permissible, so light oil removal had to be curtailed. This condition of incomplete light oil removal resulted in the decision to use cheap oil on the coal to replace the B.Th.U. removed as light oil. We operated during a number of 10-day periods, " oil on " and " oil off," the results of which were most encouraging. It was then decided to make the addition of oil a regular procedure and a contract was made for the delivery of bunker "C " oil to the plant in standard, heatable tank cars. A pump was installed to put the oil on to the coal at the entrance to the hammermill, the oil being metered and the quantity synchronized with the coal quantity. This practice has now been continued for over two years and the procedure has been adopted in some of our other plants.

By using 6 gallons of oil per ton of coal, each gallon contributing 60 cu.ft. of oil gas at 1180 B.Th.U. per cu.ft., it was possible to remove light oil almost completely. Now, when light oil is removed, the debenzolized gas amounts to 12,100 cu.ft. per ton of coal at 530 B.Th.U. per cu. ft. and a specific gravity of 0.40.

The normal send-out of 530 B.Th.U. gas has been maintained at 12,100 cu.ft. per ton of coal at a specific gravity of 0.40 and about 3 gallons of light oil have been removed.

The net replacement cost of the light oil is low. Assuming that each gallon of light oil removes 133,000 B.Th.U., about 6 gallons of bunker "C " oil (contributing 70,800 B.Th.U. per gallon) are adequate to replace the B.Th.U. removed per ton of coal. With oil at three cents per gallon, and a credit for tar and coke, the net cost of replacing a gallon of light oil is approximately three cents.

Prior to the use of oil on coal at New Haven, the light oil plant operated irregularly, light-oil removal being varied widely according to the specific gravity of the gas. It was possible to remove only about 1.6 gallons of light oil per ton of coal and maintain the required specific gravity in the debenzolized gas. For the past year and a half, using about 2.0% oil on the coal, it has been possible to remove an average of 2.5 gallons of light oil per ton of coal. At times for extended periods the light oil removal averaged 2.8 gallons per ton of coal. The high heating value of the oil gases permitted added dilution of the coke oven gas with producer gas ; this, combined with the high specific gravity of the oil gases, permitted more nearly complete removal of light oil, without decreasing the specific gravity of the gas below a required minimum. It is emphasized that the extra light oil recovered did not all come from the oil used. Rather, most of this light oil was already present in the coal gas, and the use of oil permitted the removal of additional light oil while still maintaining a required specific gravity in the debenzolized gas.

No accurate determination has been made of the light oil produced from bunker "C" oil but we believe it to amount to about 7%, by volume, of oil used. Such light oil contains no paraffins in benzene or toluene fraction.

Experience at the New Haven plant has shown that by using bunker oil in the coal mix, a coal gas plant can profitably recover 3.0 gallons of light oil per net ton of coal carbonized while maintaining the output and specific gravity of gas.

Another interesting and profitable use of oil on coal occurred in a plant where the specific gravity of the send-out gas had to be maintained at 0.45—a high figure for coke oven gas. Generally it was necessary to damper the ovens a considerable time before pushing, in order that the lean gas of low specific gravity made

* Presented at the Technical Section, Annual Convention American Gas Association, October, 1940.

near the end of the coking period be kept out of the gas. This was a decidedly wasteful manner of operating. By using about 1% of heavy fuel oil on the coal, the gravity of coke oven gas was increased sufficiently to permit the collection of all the gas.

Increased Gas Capacity

Other situations than the recovery of the light oil make the use of oil attractive. Peak-load gas is normally expensive on account of the standby equipment. In using oil, equipment is practically negligible. Since the oil is sprayed on the coal in the hammermill, the equipment may consist of tank or tank car, pump, meter, and means of synchronizing the flow of oil proportionate with the coal quantity. We have used successfully as much as 8.5 gallons of bunker " C " oil per ton of coal. This is not to be construed as the upper limit of the amount of oil which can be used. It is merely the maximum so far needed for our requirements.

If a plant is not removing light oil, by the addition of 6.3 gallons of oil per ton of coal, the gas output may be increased in a very short time, when producer-gas underfired, as much as 8%, or from 12,100 to 13,100 cu.ft. per ton of coal. When the light oil plant is in operation, this peak-load gas can be made available by slowing down the light oil recovery.

To make each 1,000 cu.ft. of peak gas, or additional gas, requires the utilization of 6.3 gallons of bunker " C " oil and 617 cu.ft. of producer gas to dilute the oil gas to 530 B.Th.U. Against this cost, there is a credit for 1.9 gallons of tar and some 10 lb. of coke. The total cost of this peak gas is reasonable and in addition standby equipment cost is negligible.

During the first three months of 1940, one plant made and sold peak-load, or additional, gas, to the extent of 5% daily average, reaching 10% for shorter periods when needed. This was gas over and above the volume which could have been made by the plant if oil had not been used on the coal.

Another instance where oil may be used to advantage is in connexion with large stocks of coke with a fixed gas demand. In such a case the output of gas may be increased 1,000 cu.ft. per ton of coal, which means that the coal carbonized and the coke produced may be decreased as much as 8% with producer gas underfiring and dilution. Actually, in one plant we have reduced coke production by 50,000 tons per year while producing as much or more gas.

While we have pointed out that it is exceedingly difficult to isolate exact results from the use of oil, one idea is paramount—when oil is mixed with coal and put in an oven, every B.Th.U. in the oil goes to some useful purpose and has a higher ultimate value than its cost. Gas, tar, ash-free carbon in coke, light oil, &c., must account for every molecule in some way and would seem an excellent outlet for such material.

Table I indicates how the flexibility of a 1,500 ton per day coke-oven plant may be increased by the utilization of some proportion of heavy fuel oil on the coal charged to the ovens.

In consideration of this Table it is at once apparent that in carbonizing the same amount of coal per day, the method of operation can produce widespread variation in gas production. For example, when operated as a straight coke oven (A) coal gas underfiring, the output of gas will be 10,200,000 cu.ft. of 580 B.Th.U. and the coke output 1,080 tons, or 9,440 cu.ft. of 580 B.Th.U. gas per ton of coke for sale, equivalent to a total of 11,470,000 cu.ft. of 530 B.Th.U. gas per day, or 10,600 cu.ft. per ton of coke.

In contrast to this we have a condition (F) where we secure an output of 19,620,000 cu.ft. of gas per day with a net coke output of 898 tons so that the gas output per ton of coke for sale is 21,850 cu.ft. of gas, an increase of over 105%.

Condition (E) removing light oil with heavy oil addition shows an output of 18,200,000 cu.ft. of gas per day. (F) shows that by shutting down the light oil plant, the output of gas per day could be increased to 19,620,000 cu.ft., or 8%—practically immediately.

Condition (C) shows the maximum production of 530 B.Th.U gas without light oil removal and no oil used on the coal. By the use of the specified amount of oil on the coal, the plant can, under condition (E), make the same volume of gas, and recover 4,500 gallons of light oil, or, under condition (F), make an additional 1,400,000 cu.ft. of gas.

If desirable, scrubbing of light oil can be controlled to remove much of the toluene and xylene, leaving the balance of the light oil in the gas for producer gas dilution.

For higher peak loads we have used up to 8.5 gallons of oil per ton of coal with consequent further peak load output. This additional 2½ gallons would produce 600,000 cu. ft. per day.

In times of low gas output it is customary to vary the amount of producer gas heating. This makes it possible to make the full output of coke when desired and reduce the gas output. In cases such as this the oil would be cut to that amount which would allow the light oil to be removed while maintaining specific gravity of the gas at its standard figure.

Quality of Products

It has been stated above that one gallon of an average bunker oil will produce 60 cu.ft. (at standard conditions) of 1,180 B.Th.U. gas, when used as part of the charge to a coke oven. Assuming that no light oil is removed from this gas it would be possible to use 97 cu.ft. of producer gas at 130 B.Th.U. to yield 158 cu.ft. of 530 B.Th.U. gas, which is about the average send-out gas. Thus, in any plant, it would be possible to increase the gas make considerably. The use of oil on the coal definitely increases the specific gravity of the total coke oven gas. This is due to two things—the oil gas itself has a high specific gravity, and the dilution with heavy producer gas is increased because of the higher heating value of the oil gas. At New Haven, the specific gravity of the partially debenzolized coke oven gas was increased from 0.399 to 0.410 by the use of 1.73% of oil on the coal, in spite of increased light oil recovery from 1.36 to 2.14 gallons per ton of coal.

Gas analyses are slightly different when using oil on the coal. Illuminants increase slightly and hydrogen decreases.

TABLE I.—Variation in Products from Plant Carbonizing 1,500 Net Tons 75/25 Mixed Coal Per Day, with Changing Operating Conditions—Coking Speed Average One Inch Per Hour.

	Coal Carb. 75 HV 25 LV N.T.	Oil Used. gall.	Gross production. Total Gas. 1,000 cu.ft.	B.Th.U.	Total Coke N.T.	Used for Underfiring. Coke Oven Gas. 1,000 cu.ft.	Coke N.T.	Used for Dilution. Coke N.T.	Prod. Gas. 1,000 cu.ft.	Gas Send-out. 1,000 cu.ft.	B.Th.U.	Sp. Gr.	Coke Surplus N.T.	L.O. Recovered. gall.	Tar Produced. gall.
A. Coal Gas Underfired No dilution No Light Oil Removal No Oil on Coal	1,500	0	16,200	580	1,080	6,000	0	0	0	10,200	580	0.36	1,080	0	11,250
B. Prod. Gas Underfired No dilution No Light Oil Removal No Oil on Coal	1,500	0	16,200	580	1,080	0	165	0	0	16,200	580	0.36	915	0	11,250
C. Prod. Gas Underfired Dilution No Light Oil Removal No Oil on Coal	1,500	0	16,200	580	1,080	0	165	13	2,020	18,220	530	0.42	902	0	11,250
D. Prod. Gas Underfired No dilution No Light Oil Removal 6 gall. Oil per N.T. Coal	1,500	9,000	16,740	599	1,087	0	171	0	0	16,740	599	0.37	916	0	13,950
E. Prod. Gas Underfired Dilution Light Oil Removal 6 gall. Oil per N.T. Coal	1,500	9,000	16,582*	569	1,087	0	171	10	1,618	18,200	530	0.40	906	4,500	13,950
F. Prod. Gas Underfired Dilution No Light Oil Removal 6 gall. Oil per N.T. Coal	1,500	9,000	16,740	599	1,087	0	171	18	2,880	19,620	530	0.45	898	0	13,950

* After light oil removal.

Each gallon of heavy oil added to the coal yields about 0.3 gallons of tar. This quantity varies with the oil used and oven temperatures and is a material credit to the oil cost. Many analyses have been made of the coke oven tar produced when oil is used on the coal and there is apparently no significant difference between it and coke oven tar made from coal alone. Exhaustive tests have been made on tar produced at a coke plant when using 0.0, 1.0 and 2.0% of oil on the coal. It was concluded that the tars produced in this plant under existing conditions did not show any properties which are unusual in coal tar.

The quantity of light oil produced per gallon of heavy oil used on the coal is difficult to determine as it has never been possible to obtain a long time test at any plant both with and without oil and with complete light oil removal. Based largely on small-scale tests, it appears that one gallon of heavy oil on the coal will yield from 0.05 to 0.07 gallons of light oil. The toluene content of this added light oil cannot be determined but there is strong indication that it is as great or greater than in normal coke oven light oil.

The use of oil on the coal in coke plants has not deleteriously affected the quality of the total light oil produced, in that there has been no increase in the paraffin content of the benzene and toluene fractions.

There is no apparent change in the appearance or quality of the coke produced from mixtures of coal with oil. The increase in coke cannot be determined accurately, but it has been estimated at about 20% by weight of the oil used.

When using these rather large proportions of oil on the coal, 1.0 to 3.5% by weight, there is generally a slight increase in the weight per unit volume of the mix over that of untreated coal. In most cases the weight of coal charged to the oven has remained the same, the oil used being charged in addition.

It has not been possible to determine with any degree of accuracy the amount of heat required for carbonization of the oil added to the coal. Apparently the oil requires more heat per pound than does coal, and an estimate of 1,800 B.Th.U. per lb. has been made as the underfiring requirements of the oil.

There has been no difficulty in handling the mixture of coal and oil in any plant. There is a decided decrease in objectionable dust in conveyor galleries and in charging the ovens. It is interesting to note that in one plant during July, 1940, when gas output was low and it became advisable to discontinue the use of oil on the coal, there was a request from the battery labour force that the oil be again put in service as it made the work less difficult when the oil was in the coal mix. Coal when treated with oil up to 3.5% by weight actually flows faster than untreated coal so that the charging time of the ovens has been reduced. Levelling time of the ovens has also been reduced. There has been no difficulty encountered in pushing the ovens when oil was used as part of the charge to the coke ovens.

Rubber conveyor belts used in handling the mixture of coal and oil will eventually show the effect of oil on the rubber. The belts tend to curl and fail to track in the idlers. Turning the belt occasionally has helped the situation, but in two plants which have used oil for a long time, the solution has been the installation of Neoprene belts. This belt change presents no great increase in unit oil costs.

Oil on Coal 0.25 to 0.5%

For the most part, when using *small* quantities of oil for the purpose of increasing or controlling the bulk density of the coal mix, and for preventing dust, moisture pick-up, and weathering we have used a coal-spray oil (viscosity of 100 seconds at 100°F.) to which had been added sufficient petrolatum to give an oil-free wax content of 7.5%. A similar coal spray oil without wax, and bunker " C " oil have been used for the same purpose, but were less effective.

For comparison, the costs of these oils at an Eastern plant are :

Coal spray oil with petrolatum	$0.076 per gall.
Coal spray oil without petrolatum 100 vis. at 100°F.	$0.061 per gall.
Bunker " C " oil	$0.030 per gall.

For the two larger tests conducted, the oil was sprayed on the coal at the mine as the coal was loaded into cars. In another test, the particular oil used was sprayed on run-of-mine coal as the coal was unloaded from a boat. In all cases, one gallon of oil was used per ton of coal, a high-volatile coal. In tests where oven charges were made this coal was used to the extent of 45 to 50% of the coal mix so that actually the coal mix contained only one-half gallon of oil per ton of coal, which is about 0.2% by weight.

There were definite indications that oil-treated coal (run-of-mine) which had been treated at the mine with one gallon per ton of an oil containing petrolatum, picked up less moisture than untreated coal of the same type. During storage in the open air in 90-ton piles, under identical conditions, moisture in untreated coal increased from 3.2% to 4.4% in three weeks and to 5.1% in eight months, while the moisture in the oil-treated coal increased from 3.4% to 4.0% in three weeks and was at 4.0% after eight months.

After storage for eight months in 90-ton piles, this high volatile coal appeared to have weathered only slightly whether oil-treated or untreated. It is doubtful if the piles were large enough to obtain any indication of the weathering which would occur in plant storage piles.

The presence of oil on coal kept the dust down exceptionally well. After eight months of storage the objectionable dust in this coal was very low, about the same as when the coal was placed in storage. The untreated coal was dusty in both instances.

Many tests were made, using the standard A.S.T.M. cubic foot box, to determine the effect of small quantities of oil on the bulk density of coal or coal mixes. In all cases, an appreciable increase in bulk density was obtained, regardless of the type of oil used, provided that the coal had normal moisture content of 2.5 to 5.0%.

With a high-volatile coal at 4.9% moisture, treatment with one gallon of oil per ton gave increases in bulk density of 7.8%, 8.4% and 9.1% for bunker oil, coal spray oil, and coal spray oil plus petrolatum respectively. Thus it is seen that the presence of petrolatum in the oil increases the effect on bulk density, but bunker oil alone is also effective.

When this same coal was used as 45% of a coal mix (this is less than 0.2% of oil in the coal mix), at 4.0 to 5.0% moisture, increases in bulk density of 14.8%, 17.1%, and 17.9% were obtained for bunker oil, coal spray oil, and coal spray oil plus petrolatum, respectively. Again, the presence of petrolatum has increased the effect of oil, although the cheaper bunker oil is also effective.

It was determined that with a coal mix of only 1.0% moisture, the bulk density of the plant coal mix was *decreased* by any proportion of oil from 0.25 to 2.0% by weight. This indicates a method of decreasing the bulk density of extremely dry coal, if desirable.

The same coal mix, with 2.5% moisture, increased from a bulk density of 43.0 to 47.0 lb. per cu.ft. with 0.25% oil. Increasing the oil content above 0.25% gradually decreased the bulk density of this coal mix until it returned to the 43.0 lb. per cu.ft. at about 2.0% oil.

In all the tests the coals used in any comparison had the same screen analysis.

It was possible to increase the weight of coal in the plant larry cars by using, as 45 to 50% of the coal mix, a coal which had been treated with one gallon of oil per ton of coal. This is about one-half gallon of oil per ton of coal mix, or about 0.2% by weight of the coal.

The weight of coal in the larry car at 4.5% moisture increased as follows :

Coal mix.	Coal in larry. lb.	Increase. lb.	Increase. %.
Untreated	23,625	—	—
Bunker oil added to coal 0.2%	25,550	1,925	8.1
Coal spray oil added to coal 0.2%	26,650	3,025	12.8
Coal spray oil and petrolatum added to coal 0.2%	26,950	3,325	14.1

In the larry car the oil containing petrolatum caused the greatest increase in bulk density, although the bunker oil was also effective. The pulverization of the coal was the same in all cases.

At one plant all the ovens were charged for several days with a coal mixture containing about 50% of a high-volatile coal which had been treated at the mine with one gallon per ton of a coal spray oil containing sufficient petrolatum to give an oil-free wax content of 7.5%. This is equivalent to one-half gallon of oil per ton of coal mix or about 0.2% of oil in the coal by weight.

Ovens which normally take 14.29 net tons of charge were operated at 15.00 tons for two days and at 15.25 tons for one full day. Five ovens were charged at 15.50 tons and five at 15.75 tons. No difficulty was encountered in pushing or charging any oven.

It is seen that the oven charge could be increased by one not in fourteen, or about 7%. Increased daily charge at this plant under these conditions would be about 150 tons of coal mix. Coking time and flue temperatures were the same during the test as for several weeks preceding, but necessarily more gas was burned for underfiring the added coal. The coke appeared to be normal and laboratory tests showed no difference on screen, tumbler, and shatter tests.

In any plant using small quantities of oil to increase the bulk density of the coal mix, thereby increasing the oven charge, it is necessary that attention be given to the possibility of employing a mixture which may be dangerously expanding. It is possible that a certain coal mix is perfectly safe as far as expansion is concerned at low bulk density, but quite dangerous at a higher bulk density.

The advantage of the use of small quantities of oil on coal to prevent dust and to control moisture pick-up is obvious.

The most startling and interesting effect of using small quantities of oil on coal of normal moisture content is the great increase in bulk density. It has been possible to increase the oven charge by one ton, an increase in plant capacity of about 7%, or 150 tons of coal per day. Because of this added coal the gas make in the plant was increased by almost 2 million cu.ft. per day. This increase in capacity is possible only if the additional coal can be carbonized in the same coking time as regularly employed without abnormally high flue temperatures.

The principal advantage of using small quantities of oil to increase the bulk density of the coal is in the possibility of maintaining uniformity of charge from day to day. Most plants have operating conditions adjusted for handling a coal of a given bulk density. In wet weather or when stock coal is used it is frequently impossible to secure the normal average weight of coal in the oven. It would be a decided advantage if, by the addition of small quantities of oil when needed, the tonnage of coal charged to the ovens could be maintained at a constant daily figure.

There is a possibility that coal, although of fairly high moisture content, when treated with small quantities of oil may act like very dry coal. If such is the case and the result in charging is that the bulk density of the coal at all points in the oven is a more nearly uniform value than is secured when charging coal without oil, a decided advantage in heating the ovens would accrue.

The fact that levelling time has been reduced when oil is used on the coal indicates that such may be the case. Since the levelling bar makes fewer passes when oiled coal is used, there is less packing of the coal in spots.

No emphasis has been placed on the cost of using small quantities of oil on the coal to obtain the advantages outlined. The quantity of oil required is not great—about one-half gallon per ton of coal mix. Based on data presented it is reasonable to assume that the oil used will pay for itself in products.

Oil on Coal at Mine

To-day, millions of tons of domestic coal are being dust-proofed with oil at the mines. The type of coal, size, and geologic age are factors in determining the dust-proofing quality and quantity of oil to be used. Our experience leads us to believe that a blended oil—*i.e.*, oil containing a quantity of material which will congeal on the surface—is the most efficient type of oil for this purpose, and the more absorbent the coal is, the greater the difference that will exist between the amount necessary to use to accomplish a dust result as compared to an unblended oil. Experience at our own mines indicates that while domestic sizes may be made permanently dustless by the use of 0.6 to 0.7 gallons per ton, slack coal may need as much as 1.0 to 1.5 gallons per ton. We feel reasonably confident that the near future will witness an extensive use of oil at the mine for the treatment of commercial coal and by-product coke plant coal supplies. This is particularly true in regard to low volatile coal for storage. By spraying with a hot blended oil at the mine many advantages may be secured. These include :

1. Less dust in handling and loss by windage and transportation.
2. Less moisture accumulation in shipment and storage.
3. Less oxidation, preserving the coking quality and by-product yields in the coal.
4. By the use of 1.5 gallons of oil per ton, of low volatile coal, the bulk density of the coal for coking will be maintained more nearly constant because :
   (*a*) The moisture will be maintained in wet or dry weather at about mine-moisture quantity.
   (*b*) By the mixture of 25% of such oil-treated low volatile coal in a 75/25 mixture, the coal going to the oven will contain 0.4 gallon of oil in the mixture. This will have the force of overcoming any high moisture of the high volatile coal and will increase the bulk density of the coal to normal.
   (*c*) If the high volatile coal is dry, the bulk density will be favourably reduced.

The cost of such treatment will be repaid not only in additional by-products but in uniformity of operation and further by the saving of windage and transportation losses.

If a coke plant intends to remove light oil, keep maximum gas output, and preserve specific gravity, the effect of 0.4 gallon of oil will prove of no particular interest, since the B.Th.U. recovered in light oil must be replaced by much larger quantities of oil. But this factor in the situation—preservation of bulk density—must be of considerable interest to the steel plant coke oven operator where steady output of standard quality is paramount.

Briefly the advantages of using oil on coal are :

1. Maintenance of a definite specific gravity in coke oven gas with removal of light oil. The B.Th.U. from bunker oil are used to replace the B.Th.U. in the light oil removed.
2. Maintenance of rather high specific gravity which is sometimes required in coke oven gas.
3. Maintenance of a definite volume of send-out gas with reduced coke production ; this is valuable when coke stock piles are too large and gas must still be made.
4. Increase in plant capacity for gas. This is accomplished by charging the oil in addition to the normal weight of coal and carbonizing in the same time. This is additional gas which can be secured at reasonable cost, limited by the quantity of oil which can be so carbonized.
5. Increase in bulk density of the coal mix charged to the ovens, thereby increasing, or maintaining under all conditions, plant capacity for coal.
6. Decrease in dust, moisture pick-up, and weathering of coals in storage or in transit.

The use of oil on coal has in no way deleteriously affected the products, such as tar, light oil, and coke.

Economies in Gas Distribution Obtainable in Works Practice

In last week's " JOURNAL " we published a Paper by Mr. A. C. Bureau, of Messrs. W. C. Holmes & Co., Ltd., given to the Scottish Junior Gas Association (Eastern District). The following is a résumé of the discussion at the meeting, which was presided over by Mr. W. Nicol Baird.

Discussion on Mr. Bureau's Paper

Mr. BAIRD, thanking Mr. Bureau, said that the Author had given a lucid story and a strong argument in favour of dehydration, benzole recovery, and desulphurization. Mr. Bureau had been careful to avoid any dogmatism, and perhaps for that reason the Paper was one that afforded ample opportunity for discussion and criticism.

Mr. S. G. MELVILLE said that sulphur removal was not so great a problem in Scotland, for the lower sulphur contents of the coals used gave lower figures than south of the Tweed. At Granton before benzole extraction, the sulphur content of the gas was 12 grains per 100 cu.ft. With an extraction of 1½ gall. of benzole per ton of coal, this became 10 grains, and with an extraction of 2 gall. per ton of coal, it dropped to 8.2 grains per 100 cu.ft. Before the introduction of vertical retorts at Granton trouble had been experienced due to naphthalene, but this was now a thing of the past. He asked if Mr. Bureau would give more details of the three works referred to in the Paper, especially the type of carbonizing plant installed. He thought that Mr. Bureau, in common with many other people, did not charge enough for labour against the plants.

Mr. W. C. CAMPBELL (Galashiels) agreed with Mr. Bureau's remarks on " Dri-Gas " plant. The additional cost of drying was amply repaid by the elimination of water troubles. He did not see the necessity of installing plant on the holder outlet in Scotland. He knew of small works with " Dri-Gas " plant on the inlet and there had been no trouble due to gum formation. Desulphurization was well worth considering, and the extra cost was well justified in view of the trouble caused by organic sulphur. The Industry had for many years realized the need for reducing the sulphur content and the answer had been found in the installation of benzole recovery plant. The one drawback in the case of smaller undertakings was the comparatively high capital cost. He thought, however, that in the national interest plant should be installed. This was being done at Galashiels. As there was no guarantee that benzole recovery would always prove remunerative, he had arranged that the design of the plant would render it easily convertible to " Dri-Gas " plant at a very small extra capital cost.

Mr. A. W. BROWN (Alloa) thought there could be no doubt of the advantages of drying. If it had not been for the present emergency he thought that one would have been installed at Alloa. They had had trouble with deposits in mains and this had been attributed to rust. The saving in distribution cost could be used to give better service to the consumer. He thought that Mr. Bureau had rightly stressed the small labour costs in connexion with benzole recovery. Apart from regular attention to oiling, &c., no alterations had been made to the setting for several months.

Mr. BAIRD thought that no one could doubt that water as well as sulphur would have to go if the Industry was to progress. The benefits of dehydration were so obvious that he wondered what case could be brought against the small outlay involved. Dealing with Mr. Bureau's balance sheet, he made the following points. He considered that the

(*Concluded on p.* 80)

Gas Products Prices

The London Market

Jan. 6.

Prices in the London Tar Products Market show no change and are approximately as follows: Pitch nominal; creosote 4⅜d. to 5d. per gallon; refined tar 3⅜d. to 4d.; pure toluene under the Ministry of Supply Toluene No. 2 Order 2s. 5d.; pure benzole 1s. 10d.; 95/160 solvent naphtha 2s. 3d.; and 90/160 pyridine 15s.; all per gallon naked; refined crystal naphthalene £23 per ton in bags; all *ex* Makers' Works.

The Provinces

Jan. 6.

The average prices of gas-works products during the week were: Pitch and Crude Tar,* Toluole, naked, North, 1s. 10d. (controlled by the Control of Toluene No. 2 Order, July 5, which fixes the maximum price at which this material may be sold). Coal tar, crude naphtha, in bulk, North 9½d. to 10d. Solvent naphtha, naked, North, 1s. 9d. to 1s. 10d. Heavy naphtha, North, 1s. 5d. to 1s. 6d. Creosote, *ex* works, in bulk, North liquid and salty, 4½d. to 4⅝d.; Scotland, 4½d. to 4⅝d.; low gravity, 4½d. to 4⅝d. Fuel Grade 4d. to 4¼d. Carbolic acid, 60's, 3s. 9d. to 3s. 10½d. Naphthalene, £15 to £20. Salts, 75s. to 85s., bags included. Anthracene, "A" quality, 4½d. to 4⅝d. per minimum 40% purely nominal. Heavy oil: Unfiltered anthracene oil (min. gr. 1,080), 5¼d. to 5½d.; filtered heavy oil (min. gr. 1,080), 5¾d. to 6d.; heavy anthracene oil gr. less than 1,080, 6d. to 6¼d.

* In regard to pitch and crude tar prices we would ask readers to refer to the editorial note in our issue of Sept. 4, 1940, p. 404.

Tar Products in Scotland

GLASGOW, Jan. 4

Trading is proceeding normally with prices of most products well maintained.

Refined tar is now no more than holding its own, but price in the home market is controlled at 4¼d. to 4⅜d. per gallon. For export supplies are offered at 3¼d. to 3½d. per gallon, both f.o.r. naked.

Creosote oil remains in good call with the prospect of substantial business being placed by the railway companies for delivery over the coming year. Values are as under: Specification oil, 5d. to 5¼d. per gallon; low gravity, 6d. to 6½d. per gallon; neutral oil, 5⅞d. to 6d. per gallon; all *ex* Works in bulk.

Cresylic acid is in small but regular call with prices for reasonable quantities as follows: Pale, 99/100%, 2s. to 2s. 2d. per gallon; Pale, 97/99%, 1s. 9d. to 1s. 10d. per gallon; Dark, 97/99%, 1s. 6d. to 1s. 7d. per gallon; all *ex* Works in buyers' packages.

Crude naphtha continues to be well looked after at 6½d. to 7¼d. per gallon *ex* Works in bulk, according to quality.

Solvent naphtha is quite active at 1s. 8½d. to 1s. 9d. per gallon for 90/160 grade and 1s. 4¼d. to 1s. 5¼d. per gallon for 90/190 heavy naphtha.

Pyridine is still quoted at 17s. to 18s. per gallon for 90/160 grade, and 19s. to 20s. per gallon for 90/140 grade.

Calendars, Diaries, &c., Received.

Seasonable gifts in the form of Calendars, Diaries, &c., have been received from the undermentioned friends, whose good wishes are cordially reciprocated:

Simon-Carves, Ltd., Cheadle Heath, Stockport.

Westwood & Wrights, Ltd., Brierley Hill, Staffs.

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A.R.P.

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GAS STOCKS AND SHARES

The Stock Exchange closed the year with a firm tone prevailing in all sections of the " House," and it is satisfactory to note that over 90% of the losses in the values of securities experienced during 1939 was recovered in 1940. British Funds commenced the New Year particularly well and were in good demand though supplies were short. Elsewhere business was on a small scale with prices generally in favour of holders. The Shell interim dividend, although halved, gave a fillip to the Oil market, but tea and rubber shares remained quiet.

Very little business was recorded in the Gas market and there were no special features. Apart from a few *ex* interest markings no changes in price took place in either the Official List or the Provincial Lists. The only alteration occurred in the Supplementary List, where the nominal quotation of Uxbridge 5% debenture closed 2 points down at 90½.

The next item of interest to investors in gas stocks will be the publication of reports and accounts for the past year. Formerly it has been quite safe to predict that dividends will show little change on previous years, but although the same cannot be said for 1940 there is every reason to believe that a large number of undertakings will distribute something approaching their 1939 rates.

Quotations on the London and Provincial Stock Exchanges

OFFICIAL LIST

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations Dec. 31.	Rise or Fall on week.
1,767,439	Sept. 16	7	7	Alliance & Dublin Ord. ...	112—122	...
374,000	Dec. 30	4	4	Do. 4 p.c. Deb. ...	90—95*	...
957,608	Nov. 4	5	5	Ascd. Gas & Water U'd'ts Ord.	12/—14/-	...
500,000	,,	4½	4½	Do. 4½ p.c. Red. Cum. Pref.	15/6—17/6	...
535,545	,,	4	4	Do. 4 p.c. Red. Cum. Pref.	14/6—16/6	...
336,646	,,	4	4	Do. 4 p.c. Irred. Cum. Pref.	12/—14/-	...
561,370	Aug. 12	7	7	Barnet Ord. 7 p.c.	98—103	...
300,000	Oct. 14	1/9⅜	1/4⅜	Bombay, Ltd.	19/6—21/6	...
690,407	Aug. 19	7	7	Bournemouth 7 p.c. max ...	100—110	...
362,025	Dec. 16	4	4	Do. 4 p.c. Deb. ...	79—84	...
659,955	Aug. 19	6¾	4⅜	Brighton, &c., 5 p.c. Con. ...	65—75	...
855,000	Sept 30	8	6	Brit. Gas Light Ord.	75—85	...
545,000	Dec. 16	5½	5½	Do. 5½ p.c. 'B' Cum. Pref	108—113	...
120,000	,,	4	4	Do. 4 p.c. Red. Deb.	73—78	...
10,000	Nov. 6, '33	6	4	Cape Town, Ltd., 4½ p.c. Cu. Pf.	¼—¾	...
626,860	July 15	5⅝	5⅝	Cardiff Con. Ord.	89—94	...
24,500	Sept. 23	7	7	Colombo Ord. 7 p.c Pref ...	19/—21/-	...
764,169	Oct. 7	/11.48	-/11.48	Colonial Gas Assn. Ltd. Ord. ...	14/—16/-	...
400,000	,,	1/3.30	1/3.30	Do. 8 p.c. Pref. ...	19/—21/-	...
1,748,935	July 22	2	3	Commercial Ord.	37—42	...
620,000	Dec. 9	3	3	Do. 3 p.c. Deb.	57—62	...
286,344	Aug. 19	5	5	Do. 5 p.c. Deb.	87—92	...
807,560	Aug. 12	7	6	Croydon sliding scale	83—88	...
644,590	,,	5	5	Do. max. div.	79—84	...
620,385	Dec. 30	5	5	Do. 5 p.c. Perp. Deb. ...	90—95*	...
179,500	Aug. 19	5½	5	East Surrey 'B,' 5 p.c.	60—70	...
176,461	Dec. 16	5	5	Do. 5 p.c. Deb. (Irred.)...	87—92	...
250,000	Nov. 11	4	6	Gas Consolidation Ord. 'B' ...	13/6—14/6	...
250,000	Nov. 11	4	4	Do. 4 p.c. Red. Cum. Pref.	15/—17/-	...
19,123,081	July 29	3½	4½	Gas Light & Coke Ord. ...	14/—15/-a	...
2,600,000	,,	3½	3½	Do. 3½ p.c. max.	50—55	...
4,477,106	,,	4	4	Do. 4 p.c. Con. Pref. ...	72—77	...
2,993,000	July 8	3¾	3¾	Do. 3¾ p.c. Red. Pref. ...	82—87	...
8,602,497	Dec. 2	3	3	Do. 3 p.c. Con. Deb. ...	69—74	...
3,642,770	,,	5	5	Do. 5 p.c. Red. Deb. ...	100—105	...
3,500,000	,,	4½	4½	Do. 4½ p.c. Red. Deb. ...	98—103	...
700,000	Sept. 9	3½	3½	Do. 3½ Red. Deb. ...	80—85	...
5,600,000	May 13	4	8	Imperial Continental Cap. ...	39—44	...
43,820	July 29	3½	3½	Do. 3½ p.c. Red. Deb. ...	63—68	...
231,978	Aug. 19	5	5	M.S. Utility 'C' Cons.	68—73	...
918,657	,,	4	4	4 p.c. Cons. Pref.	72—77	...
675,000	Nov. 11	†4	†4	Montevideo, Ltd.	52—57	...
300,000	Nov. 18	7	9	Oriental, Ltd.	100—110	...
368,537	Dec. 9	8	6½	Plymouth & Stonehouse 5 p.c.	88—98	...
621,667	Aug. 19	8½	7½	Portsmouth & Gosport Cons.	90—95	...
648,999	Sept. 16	1/1	1/1½	Severn Val. Gas Cor. Ld. Ord.	13/—15/-	...
597,972	,,	-/10½	-/10⅝	Do. 4½ p.c. Cum. Pref. ...	15/6—17/6	...
2,528,714	Sept. 2	1/-	-/7½	South East'n Gas Cn. Ld. Ord.	9/—11/-	...
1,000,000	,,	-/10½	-/10⅝	Do. 4½ p.c. Red. Cum. Pref.	14/—16/-	...
1,068,869	,,	4	4	Do. 4 p.c. Irred. Cum. Pref.	12/6—14/6	...
6,709,895	Aug. 5	4	4	South Met. Ord.	53—58	...
1,135,812	,,	6	6	Do. 6 p.c. Irred. Pref. ...	100—105	...
850,000	,,	4	4	Do. 4 p.c. Irred. Pref. ...	69—74	...
1,895,445	Dec. 30	3	3	Do. 3 p.c. Perp. Deb. ...	60—65*	...
1,000,000	July 15	5	5	Do. 5 p.c. Red. Deb. ...	97—102	...
1,543,795	July 22	3	4	South Suburban Ord. 5 p.c. ...	62—67	...
$12,825	July 8	5	5	Do. 5 p.c. Perp. Pref. ...	85—90	...
500,000	,,	4	4	Do. 4 p.c. Perp. Pref. ...	63—68	...
250,000	,,	3⅜	3⅜	Do. 3⅜ p.c. Red. Pref. ...	80—85	...
888,587	Dec. 16	5	5	Do. 5 p.c. Perp. Deb. ...	90—95	...
750,541	Aug. 9	5½	5	Southampton Ord.	57—62	...
350,000	Feb. 12	5½	5½	Swansea 5½ p.c. Red. Pref. ...	91—96	...
1,076,495	Aug. 5	5	5	Tottenham & District Ord. ...	62—67	...
338,555	,,	5	5	Do. 5 p.c. Pref.	78—83	...
453,380	Dec. 9	4	4	Do. 4 p.c. Perp. Deb. ...	76—81	...
1,247,505	May 20	4	6	U. Kingdom Gas Cor. Ord. ...	13/—15/-	...
1,085,952	Nov. 25	4½	4½	Do. 4½ p.c. 1st Cum. Pref. ...	13/6—15/6	...
772,709	,,	4	4	Do. 4 p.c. 1st Red. Cum.Pref.	13/—15/-	...
745,263	Dec. 16	4½	4½	Do. 4½ p.c. 2nd Non.Cum. Pf.	12/—14/-	...
1,200,000	Sept. 9	3½	3½	Do. 3½ p.c. Red. Deb. ...	82—87	...
380,606	Aug. 5	7	6¾	Uxbridge, &c., 5 p.c.	80—90	...
1,371,138	July 8	3½	4	Wandsworth Consolidated ...	66—71	...
2,525,768	,,	4	4	Do. 4 p.c. Pref.	63—68	...
1,343,964	Dec. 16	5	5	Do. 5 p.c. Deb.	88—93	...
383,745	,,	4	4	Do. 4 p.c. Deb.	75—80	...
558,342	July 15	6	5	Watford & St. Albans Ord. ...	85—90	...
300,000	Dec. 9	3½	3½	Do. 3½ p.c. Red. Deb. ...	84—89	...

SUPPLEMENTARY LIST

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations Dec. 31.	Rise or Fall on week
351,685	Dec. 16	5	5	Brighton, &c., 5 p.c. Perp. Deb.	88—93	...
28,700	,, 17	5½	5½	Do. 5½ p.c. Red. Deb. 1942 ...	95—100	...
415,250	,, 23	4	4	Bristol Gas Co., 4 p.c. New Deb.	83—88	...
140,205	July 29	7	7	Cambridge, &c., 7 p.c. Cons. 'B'	100—110	...
295,932	Aug. 19	5	5	Cheltenham, 5 p.c. Cons. Ord....	88—93	...
42,500	Dec. 16	4	4	Do. 4 p.c. Perp. Deb....	75—80	...
150,000	Aug. 12	4	4	Croydon Gas, 4 p.c. Pref. (Irr.)	65—75	...
130,000	Dec. 30	4	4	Do. 4 p.c. Deb. ...	75—80*	...
146,700	Aug. 19	5½	5½	East Surrey, 5½ p.c. Pref. 'A' ...	80—90	...
53,220	,, 19	6	6	Do. 6 p.c. Cum. Pref. ...	90—100	...
117,425	Feb. 5	8	8	East Wight, 5 p.c. Cons. Ord. ...	100—110	...
	Aug. 19	6	4	Eastbourne, 'B' 3½ p.c....	65—75	...
239,135	Nov. 11	5	5	Gas Consolidation 'A' Ord. (£1)	13/—15/-	...
156,600	Aug. 19	5	5	Hampton C't, 5 p.c. Cons. Ord.	68—73	...
18,000	Dec. 2	7	7	Malta & Med'n., 7 p.c. 1st Pref.	55—65	...
10,845	,, 2	7½	7½	Do. 7½ p.c. 2nd Pref.	55—65	...
50,000	Aug. 19	£5 19 6	£5 4 6	Mid. South. Util., 'A' Cons. 5 p.c.	60—70	...
65,000	Aug. 12	5	5	North Middlesex, 5 p.c. Pref. ...	87—92	...
70,000	Sept. 9	5	5	Plymouth & Stone., 5 p.c. Deb	87—92	...
76,501	Dec. 30	4	4	Reading, 4 p.c. Perp. Deb. ...	75—80*	...
74,777	Sept. 30	4	4	Romford, 4 p.c. Debs. (Reg.) ...	77—82	...
21,000	Dec. 16	5	5	Slough, 5 p.c. Perp. Deb. ...	87—92*	...
211,740	,, 30	5	5	Southampton, 5 p.c. Red. Deb.	90—95*	...
363,575	July 1	5	5	Tottenham, 5 p.c. Reg. Red. Mt.	95—100	...
202,019	Oct. 14	6⅛	6⅛	Tunbridge Wells, 4 p.c. Scale ...	70—80	...
135,257	June 10	5	5	Uxbridge &c., 5 p.c. Perp. Deb.	88—93	-2

PROVINCIAL EXCHANGES

					Quotations Dec. 27.	
47,756	July 26	6	5	Bath Cons.	94—98	...
122,577	July 22	7	6	Blyth 5 p.c. Ord.	100—105	...
1,667,250	July 15	5	5	Bristol, 5 p.c. max.	90—93	...
120,420	Dec. 16	4	4	Do. 1st 4 p.c. Deb.	92½—94½*	...
415,250	,,	4	4	Do. 2nd 4 p.c. Deb. ...	91—94*	...
328,790	,,	5	5	Do. 5 p.c. Deb.	107—110*	...
157,150	Aug. 5	6½	5	Chester 5 p.c. Ord.	98—101	...
92,500	Dec. 16	4	4	Do. 4 p.c. Pref.	79—84*	...
36,430	,,	3½	3½	Do. 3½ p.c. Deb.	79—84*	...
41,890	,,	4	4	Do. 4 p.c. Red. Deb. ...	93—97*	...
542,270	Aug. 12	9	6	Derby Cons.	100—105	...
55,000	June 10	4	4	Do. 4 p.c. Deb.	96—102	...
10,000	Aug. 19	10	10	Great Grimsby 'A' Ord. ...	165—175	...
6,500	,,	10	10	Do. 'B' Ord. ...	165—175	...
79,000	,,	10	10	Do. 'C' Ord. ...	155—165	...
732,000	Aug. 26	4	4	Hartlepool G. & W. Cn. & New	61—63	...
2,167,410	Aug. 19	6	6	Liverpool 5 p.c. Ord.	97—100	...
245,500	Dec. 16	5	5	Do. 5 p.c. Red. Pref. ...	97½—100½*	...
306,083	July 15	4	4	Do. 4 p.c. Deb.	99—101	...
20,000	June 24	5	5	Long Eaton 5 p.c. Pref.	9—11	...
80,000	June 24	5	5	Do. 5 p.c. Deb.	92—97	...
2,430,267	July 29	5⅞	5	Newcastle and Gateshead Con.	16/3—17/3a	...
682,856	,,	4	4	Do. 4 p.c. Pref.	75—77	...
776,706	Dec. 23	3½	3½	Do. 3½ p.c. Deb.	80—85*	...
277,285	Oct. 21	5	5	Do. 5 p.c. Deb. '43 ...	97—102	...
274,000	July 26	5	5	Newport (Mon.) Ord.	89—93	...
13,200	Sept. 16	8⅔	7	Pontyp'l Gas & W. 10 p.c. 'A'	11½—12½	...
13,600	,,	6	5	Do. 7 p.c. 'B'	9½—10½	...
40,000	,,	5	6	Do. 7 p.c. 'C'	9½—10½	...
106,280	Aug. 5	8	10	Preston 'A' 10 p.c.	157—167	...
188,219	,,	7	7	Do. 'B' 7 p.c.	113—123	...
1,806,339	Aug. 26	6½	6½	Sheffield Cons.	118—120	...
95,000	July 8	4	4	Do. 4 p.c. Deb.	97— 99	...
332,351	Feb. 5	6	5	Sunderland 6 p.c. max. ...	107—112	...
140,778	Aug. 12	5	5	Weston-super-Mare Cons. ...	80—85	...
64,338	June 24	4	4	Do. 4 p.c. Deb.	75—85	...
33,340	,,	7½	7½	Do. 7½ p.c. Deb.	137—145	...

a.—The quotation is per £1 of Stock. * Ex div. † Price free of income-tax.

charge of 1s. 6d. per 1,000 lb. for steam was low, and that for a hand-fired boiler it should be about 1s. 9d. In his Presidential Address Mr. Rea had given the figure of £16 per ton as the cost of calcium chloride. He wondered if Mr. Bureau's figure was correct. If the plant were on the inlet of the holder he thought that the cost of oil-filming should be taken into consideration. None of these points should be omitted, but at the same time it did not over-rule the necessity of drying the gas. Regarding the case of $CaCO_3$ sludge formation, he thought that the NH_4Cl formed would be dissociated by the evaporator giving a slightly acid solution which would decompose the carbonate of lime already formed. Some confusion existed with regard to combined Drigas and benzole plants in the matter of calorific values. The increase in C.V. due to removal of water vapour counteracted to some extent the reduction due to the removal of benzole. So long as there were fluctuating coke markets the economics of benzole recovery would fluctuate accordingly. Again, the price of coal at present kept rising. Eventually, if the price of benzole did not rise in comparison, coke and gas would have to bear the burden of the increase. Reverting to the balance sheet, he thought that allowance should be made for wear and tear on the carbonizing plant, and also there was the fact that a decrease in retort reserve had been made which might require extensions to plant. With the active carbon process of benzole recovery thiophene and CS_2 were removed in the early stages of absorption, and these were later displaced as the saturation of the carbon increased. It would appear as if a short-cycle active carbon plant in combination with a limited oil-washing process would approach the matter in a more efficient manner. Perhaps much better was the South Metropolitan Company's method of CS_2 removal by passing the gas over nickel heated to about 300° C. This method cost about 0.07d. per therm.

Mr. R. J. GAVIN (Melrose) made the point that the time had come when they should remove the last traces of sulphur from the gas if they were to put out a portable heater to compete with the portable electric heater. Dehydration was becoming an essential, and many trying experiences could have been avoided last winter had gas drying been practised. He had a high pressure gas main frozen last winter. He hoped to avoid any possibility of a recurrence of this as he had installed an old boiler on the outlet side of the compressor through a non-return valve and hoped this would take up any deposition of water vapour. The gas pressure was 10 lb. per sq. in. Would there have been any trouble with condensation had the gas been dried before compressing ?

Mr. BUREAU, replying, said he had endeavoured to deal with the various subjects generally and not with respect to Scotland only. The figure of 8.2 grains per 100 cu.ft. was very good for a partial benzole recovery. As a general figure 30 to 40% sulphur removal was a fair estimate in conjunction with benzole recovery. The works referred to in the Paper carbonized in the following manner :

370	million	cu.ft.	Horizontals.
560	,,	,,	Verticals.
680	,,	,,	,,
1,120	,,	,,	Horizontals and verticals.
1,600	,,	,,	Verticals.

Gum trouble was not so widespread in Scotland largely owing to the preponderance of vertical retorts in which dilution was by water gas rather than overpulling. This latter practice introduced nitric oxide which, according to Dr. Hollings, was largely responsible for gum formation.

The Alloa figure of 4 to 5 grains of sulphur must rank among the lowest, and was probably due to a low concentration of carbon oxysulphide in the gas, combined with a plant presumably capable of a larger throughput than that with which it was now dealing. He thought that 1s. 6d. was a figure normally taken for steam, which might be low in some cases, but should be adequate for an installation with a waste heat boiler. The cost of calcium chloride given in the Paper was approximately correct, since his firm were able to supply it for dehydration purposes at round about that figure at the present day.

He had to confess that he had omitted to take the cost of oil-filming into account, as he had been dealing rather with plants situated on the outlet of the holder ; but he suggested that some consideration of the beneficial action of the oil on the holder plates should be allowed against the cost of filming to the Drigas plant. It was difficult to allow for the cost of oil-filming as a general case owing to the variation in size of holders for undertakings of a similar capacity. In practice it was found that the amount of carbonate sludge found in dehydration plants was in proportion to the ammonia in the gas.

Regarding the benzole balance sheets, good arguments could be put forward on behalf of the method of presentation adopted, but since the profit obtainable by benzole recovery was not the subject of the Paper, he would suggest that any additional costs would be cancelled out by subtraction in the estimation of the differential cost of desulphurization as arrived at in the particular case cited. The combination of oil washing and active carbon absorption opened up possibilities, but would probably convert the process from a continuous to an intermittent one. The catalytic process of sulphur removal presented its own particular problems, and at the present time there appeared to be no imminent prospects of such a plant being put on the market. Refrigeration could, no doubt, be adopted for the removal of sulphur and for dehydration, but the practical difficulties involved and the power costs were high. Compression to 10 lb. per sq.in. on dried gas would not give trouble with water deposition on the district.

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